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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

FOREST INSECT INVESTIGATIONS

PROGRESS REPORT OF A STUDY OF THE BLACK HILLS BEETLE EMERGENCE IN SOUTHEASTERN WYOMING SUMMER OF 1936

By

J. M. Whiteside

and

J. A. Beal

Forest Insect Laboratory,
Fort Collins, Colorado
April 1, 1937.

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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

WASHINGTON, D. C.

Forest Insect Laboratory,
Fort Collins, Colorado,
April 29, 1937.

Dr. F. C. Craighead,
Washington, D. C.

Dear Doctor Craighead:

I am enclosing for your information copy of a progress report covering the caging studies carried on by Whiteside on the Elk Mountain area last year. In so far as possible I have followed the same outline as used by him last year so that the two years' records can be easily compared.

There is not a great deal of new information in this report; however, it indicates how inadequate records for a single season may be. We feel that we got a good start on the brood counts but here again we do not have sufficient information for very definite conclusions. We were working under the same handicap with which we were confronted last year in not having a full time man on this project. Whiteside had to spend the major portion of his time on other work. I feel that with a full time assistant on this project we could rear more of the associated insects and keep them in better shape for final determinations. I also believe that we could find out more about the parent adults.

You will note that there is some evidence to indicate rather rapid increase in the infestation in lodgepole pine on Mullison Creek. With the Elk Mountain infestation not too far removed, I am not sure that we can attach very much significance to this increase, especially since we do not know how far these beetles will fly.

I am sending copies of this report to our other western stations, one to Whiteside, and one to the Regional Office and Medicine Bow National Forest. Since the Forest Service financed this project we are almost obligated to furnish them with a report on it.

Sincerely yours,

J. A. Beal, Entomologist,
Forest Insect Investigations

cc-Miller
Evenden
Keen

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Abstract

For the past two seasons studies have been conducted on the life history and habits of the Black Hills beetle (Dendroctonus ponderosae Hopk.) in the Elk Mountain area of southeastern Wyoming.

In 1935 emergence of the Black Hills beetle from the lower bole of limber pine was about 9 times that from lodgepole pine, but in 1936 it was less than twice as great. The reason for this is that emergence from limber pine dropped from 164.5 to 89.1 beetles per square foot while emergence from lodgepole pine increased from 18.2 to 51.9 beetles per square foot. In 1936 comparative brood counts taken 4 feet from the ground showed 3 times as much brood in limber pine as in lodgepole pine, being 150.3 and 49.8 respectively. More significant were the brood counts made on entire infested tree length which gave 33.3 beetles from lodgepole and 130.4 in limber pine or nearly 4 times as many as from lodgepole.

The 1936 emergence occurred about 2 or 4 weeks earlier than the 1935 emergence, peak emergence averaging 2 weeks earlier.

About 9 percent of the brood between elevations of 9,000 feet and 10,000 feet required two years for their complete development. These "second year" beetles started emerging from 3 to 4 weeks ahead of normal emergence.

Parasites, predators, and associated insects do not appear to

be abundant enough to play a very important part in the trend of the epidemic of the Black Hills beetle.

The Elk Mountain infestation has apparently increased since 1934 at the rate of about 300 percent each year.

The Mullison Creek infestation, in a pure stand of mature lodgepole pine, apparently built up from a light infestation in 1934 to about 400 infested trees per section in 1936.

PROGRESS REPORT OF
A STUDY OF THE BLACK HILLS BEETLE EMERGENCE
IN SOUTHEASTERN WYOMING
SUMMER OF 1936.

Introduction

In order to obtain more accurate information upon which to base recommendations concerning control practices against the Black Hills beetle (Dendroctonus ponderosae Hopk.) in the central Rocky Mountain region a study of the life history and habits of this insect was begun in 1935 and continued during 1936. The present report deals principally with the past season's data except where comparisons are made, thus for complete information on the 1935 study reference should be made to Whiteside's report[1/] dealing with that period. In so far as is deemed advisable data are herein presented in the same form as that used last year. This method will facilitate a comparison of the two seasons' records.

The objectives of this study were as follows:

(1) To obtain data on the comparative number of beetles emerging from limber pine and lodgepole pine.

(2) To determine the beginning, duration, end, and peak of emergence.

1/ Whiteside, J. M. "Progress Report of a Study of the Black Hills beetle Emergence in Southeastern Wyoming Summer of 1935" Unpublished progress report.

(3) To obtain data on the possibility of parent adult emergence.

(4) To obtain information on associated insects — parasites, predators, scavengers, etc.

In some of these objectives we have been fairly successful, in others not so fortunate, and we have also obtained some additional data on other important points such as the discovery of a two-year life cycle at high elevations.

The Area

The area selected for this study was on Elk Mountain, Carbon County, Wyoming. This mountain, rising to a height of 11,162 feet and covered with a fair stand of lodgepole pine, limber pine, Engelmann spruce, and Douglas fir, is located four to five miles north of the Medicine Bow National Forest boundary. The Black Hills beetle infestation here has reached epidemic proportions during the past three or four years. A survey made in 1935 revealed that approximately 79 percent of the infested trees were limber pine and only 21 percent were lodgepole pine, with the heaviest infestation on the south and entire west portion of the mountain. Since no control work has been attempted on the area, the situation is ideal for study purposes. Variations in elevations, tree species, site, and exposure are available. However the remoteness of the area and the rough terrain make all work physically difficult.

During 1936 additional work was done in a lodgepole pine type infestation on the Mullison Creek area of the Medicine Bow National Forest at an elevation of 8,500 feet.

Procedure

As in 1935 portions of both limber pine and lodgepole pine trees were caged at three elevations, eight, nine, and ten thousand feet on the southwest portion of the mountain. Data were obtained from eight limber pine and six lodgepole pine, one set of cages having been molested by a bear was not used. In addition, cages were placed on nine lodgepole pine trees on the Mullison Creek area at eight thousand five hundred feet elevation. All cages of the previous year were left in place and regular collections also made from them.

The number of caged trees at each elevation is as follows:

	Lodgepole Pine		Limber Pine	
Elevation	1935	1936	1935	1936
8,000 ft.	5	3	4	3
8,500 ft.	-	9	-	-
9,000 ft.	4	2	4	2
10,000 ft.	4	2	6	3
	13	16	14	8

Cages were made from 18-mesh copper screen and cut to cover an area 2 feet long and 1 foot wide, or 2 square feet of bark surface. Attached to the bottom of the cage was a small removable collecting can into which the emerging beetles fell. The edges of the cages were held snugly against the bark by strips of galvanized metal.

Some cages were placed in position immediately upon completion of attack, others just prior to emergence. In this way it was hoped to obtain data on parent adult emergence, and differences in parasites and predators and their effect on beetle population.

In order to supplement the caging data brood counts were made on twelve limber pine and the same number of lodgepole pine at different elevations of eight, nine, and ten thousand feet. All counts were made on one half square foot units. Two units or one square foot were sampled on both the north and south sides of all trees at seven foot intervals from a height of four feet above ground to the top of the tree or to the uppermost limbs of the infested portion of the trunks.

Collections

In so far as possible weekly collections were made from all cages from the beginning of emergence to the end. The Black Hills beetle adults were counted and recorded but they were not saved. All associated insects were saved and kept in a separate vial maintained for each cage. A Riker mount was kept for limber pine and lodgepole pine as a display of the associated insects. Each species was given a number and these numbers recorded in the field notes. These associated insects were counted and stored in a large vial and marked as to host and number. Following each collection the number of insects collected was entered opposite the date of collection.

Brood Counts

Just prior to emergence of the Black Hills beetle, brood counts were made on a number of infested pines in the vicinity of the caged trees in order to supplement the data from the caging study. In all, 151 square feet of bark were examined from 24 trees, half of which was lodgepole pine and the remainder limber pine. The brood data are summarized in Table I. Most of the brood was in the young adult stage although some pupae and larvae were found.

In lodgepole pine the heaviest brood was found at a height of 4 feet on the trees and averaged 49.8 insects per square foot of bark surface. The number of insects decreased rapidly toward the top with averages of 32.9 at 11 feet, 23.7 at 18 feet, 22.9 at 25 feet, and 17 at 32 feet. This gave a total average of 33.3 insects per square foot for the entire infested length of the trees. The average number of attacks per square foot in lodgepole pine was 7.5 or 15 attacking beetles. Assuming that the brood counts fairly accurately indicated the number of emerging beetles (33.3) then it appears that in 1936 the increase in population in lodgepole pine was approximately 100 percent. That is, twice as many beetles emerged from lodgepole pine as attacked it.

In limber pine the heaviest brood was also found at a height of 4 feet where it averaged 150.3 beetles per square foot of bark surface. The number of insects decreased somewhat toward the top with averages of 135.6 at 11 feet, 105.7 at 18 feet, and 124.6 at 25 feet.

Average attack per square foot in limber pine is 14.1 or 28.2 attacking beetles, figuring two beetles per attack. The average brood throughout the infested length of limber pine is 130.4 per square foot, with an apparent increase in 1936 of 362 percent or 4.6 times as many beetles emerged from limber pine as attacked it. It should be noted that fairly heavy brood persisted throughout the infested length of limber pine trees and further that it is about 4 times as heavy as the brood in lodgepole pine.

The lodgepole pine felled for brood counts varied from 9.5 to 20.5 inches d.b.h. and averaged 13 inches. It varied from 35 to 82 feet in height, averaging 52 feet, and infested length varied from 17 feet to 40 feet, averaging 25 feet. Diameters of limber pine varied from 10.5 to 24.7 inches, averaging 15 inches. In height it varied from 27 to 47 feet, averaging 37.8 feet, and infested length varied from 20 to 38 feet, averaging 26.7 feet. Thus approximately 70 percent of the total height of limber pine was infested while only about 50 percent of the total height of lodgepole pine was infested. Although the lodgepole pine averaged about 14 feet taller than the limber pine the height of infestation for the two species was very close together, being 25 and 26.7 feet respectively.

A more complete analysis of brood count data taken on 10 trees (Table II) indicates that in lodgepole pine the attack per square foot decreases toward the top but remains fairly constant in limber pine.

Attack in lodgepole averages only 7.5 per square foot but in limber pine is nearly double this figure, being 14.1. There exists a fairly close relationship between the number of attacks, the amount of gallery constructed, and the brood in both host trees. The following table will serve to illustrate this point.

Lodgepole Pine

Height of sample on tree	Number of attacks per square foot	Inches of gallery per attack	Number of brood per attack	Number of brood per inch of gallery
4 feet	11.2	10.9	5.1	.46
11 "	7.3	13.5	3.8	.28
18 "	5.8	14.3	4.2	.30
25 "	2.7	13.4	5.7	.42
Average	7.5	12.5	4.6	.37

Limber Pine

4 feet	14.2	10.4	6.6	.64
11 "	17.2	9.9	5.2	.53
18 "	12.0	11.7	8.3	.70
25 "	11.5	14.4	10.6	.74
Average	14.1	10.9	6.9	.63

While attacks are only about half as numerous in lodgepole pine as in limber pine the number of inches of gallery per attack is a little more, the number of brood per attack is about two-thirds the number found in limber pine, and the number of brood per inch of gallery in lodgepole pine is only about half the number found in limber pine.

Data were also taken on the parasites and predators found during the brood counts although they were not kept separate by species.

In lodgepole pine there were 6.1 Hymenopterous parasites per square foot, .04 Dipterous parasites, and 1.5 Clerids. In limber pine these insects numbered 1.3 Hymenopterous parasites, 1.8 Dipterous parasites, and 1.4 Clerids per square foot. There were nearly five times as many Hymenopterous parasites in lodgepole pine as in limber pine. The thinner bark of lodgepole may have aided oviposition by the adult parasites thus accounting for this difference.

The number of brood count samples taken to date is too small for us to determine the accuracy of half foot samples as compared with whole foot samples of bark.

New Adult Emergence

Random field examinations in this region have often indicated that the Black Hills beetle population beneath the bark of limber pine is greater than in lodgepole pine. Since cages were usually placed at an average height of about 4 feet comparisons will be limited to data taken at this particular height. These data indicate that the average attack at 4 feet on lodgepole pine is 11.2 per square foot and 14.2 on limber pine. In 1935 emergence obtained from the cages on lodgepole pine averaged only 16.2 beetles per square foot and 164.5 or about 9 times as many from limber pine. No such wide difference was found in either the caging records or brood counts of 1936. From cages on lodgepole, beetles emerged at the rate of 51.9 per square foot and from limber pine at the rate of 89.1. Brood counts on lodgepole

showed 49.6 mature insects for each square foot examined and 150.3 for limber pine. Summaries are given below:

Year	Method	Square feet of Bark: Lodgepole	Limber	Brood per square foot: Lodgepole	Limber
1935	Caging	28	32	18.2	164.5
1936	"	40	32	51.9	89.1
1936	Brood counts	22	23	49.6	150.3
	Weighted averages			40.8	133.0

Following the procedure used last year there are several tables at the end of this report which are chiefly significant as a record and reference for future collection and caging studies on this area. They are included so that the 1936 data will be complete and on a basis comparable to the 1935 data. Table III, from which most of the above summary of caging data was taken, shows emergence on two sides of the trees and the total number of beetles collected from all cages on both species of 1935-attacked trees. An examination of the number of emerging beetles from different cages shows a wide variation both in limber pine and lodgepole pine. With emergence varying from 67 to 400 beetles per cage (2 sq. ft.) in limber pine and from 8 to 246 beetles in lodgepole pine the average figures on emergence appear to lose their significance, still they are the only available means for comparing the data and must therefore be used. Table IV for limber pine and Table V for lodgepole pine, show the number of beetles collected on each visit to the caged trees, together with the percentages of the total emergence which these numbers represent. A summary of the data from these tables is given in Table VI. Much of the data contained in tables four to six inclusive is graphically presented

in charts one, two, and three.

Two-Year Emergence

During this study it has been found that at elevations between nine and ten thousand feet, portions of the brood sometimes require two years for their complete development. Examinations made at intervals during the summer and late fall of 1935 on trees adjacent to those caged (1934 attack) showed that, at 10,000 feet, pupae and callow adults were still present under the bark when emergence was nearly over. These insects started emerging late in June 1936, nearly a month ahead of normal emergence.

Some second year emergence took place from all cages on both limber pine and lodgepole pine at 10,000 feet. At 9,000 feet emergence occurred in three out of four cages on limber pine but no beetles emerged from lodgepole at this elevation.

Records from 24 square feet of bark showed that 91 percent of the beetles at high elevations emerged the first year after attack and that 9 percent emerged the second year following attack (Table IX). The importance of this early attack is shown in data gathered on one 8-acre strip sample plot which was cruised at intervals of two weeks during 1936. On July 17, and before the main flight occurred, 106 trees contained new attack. On July 30, following the main flight, 166 additional trees were attacked. On August 14 only 42 additional trees were attacked and by August 28 nine more trees showed attack.

This gives a total of 323 new trees on the plot during 1936 of which 106 or approximately one-third were attacked by the "second year" beetles. If this is reduced to an acre basis, we have slightly over 40 new trees per acre of which approximately 13 are the result of early season attack. This habit of the Black Hills beetle at higher elevations has a very important bearing on control practices. In many areas it will be necessary for spotters to examine all two-year old attacks and mark many of them for treatment.

The Duration of Emergence

In general the 1936 emergence of the Black Hills beetle was two or three weeks earlier than in 1935. In 1936 at 8,000 feet initial emergence from both hosts occurred between July 10 and July 15 whereas in 1935, it occurred about the first of August. At 8,500 feet elevation first emergence occurred prior to July 15, 1936. At 9,000 feet during 1936 first emergence occurred between July 10 and July 15 from limber pine and between July 18 and July 25 from lodgepole pine. Last year emergence at this elevation started August 7. At 10,000 feet there was unseasonably early emergence from both host species on July 10. No satisfactory explanation can be given for this occurrence although it is possible that they may have been parent adults. Aside from these first few beetles on July 10 and a few more on July 16 no other emergence took place at this elevation until July 25. Last year it began on August 15 at this elevation.

Charts two and three show the percentages of the total emergence on different collection dates for lodgepole and limber pine respectively. The results from the north and south cages have been plotted separately. From the data in these two charts Table VII has been prepared, showing the dates and number of days after the initial emergence on which important percentages of emergence took place. For the purpose of simplification there is given below a summary of Table VII in which the north and south data for both species have been averaged.

Elevation	Tree Species	50% Emergence	75% Emergence	90% Emergence	100% Emergence
8,000 ft.	LP	10*	16	23	51
	LPP	15	15	22	50
8,500 ft.	LP	-	-	-	-
	LPP	13	13	20	67
9,000 ft.	LP	23	23	30	54
	LPP	20	20	27	41
10,000 ft.	LP	32	36	43	56
	LPP	24	24	31	52

LP = Limber Pine. LPP = Lodgepole Pine

* Number of days after start of emergence.

One peculiarity of these records (Table VII) is shown by the fact that practically all emergence ceased at about the same time (September 4-11) with an occasional late beetle collected in October. It is also peculiar that contrary to last year's data first emergence occurred at 10,000 feet on July 10 and last emergence occurred at 8,500

feet on October 6. Another unexpected discrepancy is shown in chart two where the curves for emergence from lodgepole pine at nine and ten thousand feet are the reverse of what would normally be expected.

A better understanding of comparative emergence from lodgepole pine and limber pine, the start, peak, and end of emergence is obtained by plotting the number of emerging beetles per square foot with the dates of emergence, charts four and five. Bearing in mind the fact that one week lapsed between collections we find that in lodgepole pine at 8,000 feet emergence started on July 15, reached its height July 31 and continued to September 11. At 9,000 feet it began July 25, reached its maximum on August 14 and ended September 11. At 10,000 feet it began July 10, reached its maximum on August 21 and also ended on September 11.

Emergence from limber pine at 8,000 feet started July 15, reached its height on July 31 and ended September 11. At 9,000 feet it began July 15, reached a peak on August 7 and ended September 11. At 10,000 feet it began July 10, reached a maximum on August 14, and terminated September 11. Thus the peak of emergence appears to be a better criterion of beetle emergence than either the initial or final emergence.

While the general pattern is similar for both host species the data indicate a somewhat slower emergence from lodgepole pine at nine and ten thousand feet than from limber pine. The true picture may here be obscured by the length of time between collections.

In most cases there is evidence of an early peak on July 25 with a subsequent dropping off in the number of beetles collected. This was caused by a period of cold, rainy weather which coincided with the lighter collections.

Parent Adult Emergence

Some cages were placed on trees shortly after attack had been completed in order to obtain further information on parent adult emergence. The detailed data on re-emerging parent adult beetles are given in Table VIII. Some beetles were collected from all cages installed for re-emergence but they varied greatly from as low as one to as high as twenty-eight per cage.

The following is a summary taken from Table VIII:

Tree species	Square feet of bark caged	Total number of parent adults emerging	Average number per square foot
Lodgepole pine	12	72	6
Limber pine	8	40	5

The results of these cagings agree with those obtained last year indicating that considerable parent adult emergence takes place following the attack. Unfortunately the re-emerging beetles were either lost or inadvertently destroyed and no comparison can be made as to the number of males and females. Since these beetles re-emerged during the regular summer emergence period it is doubtful that they would be much of a factor in control practices. Even if they made second attacks these would be found in the course of regular surveys and spotting work.

Effect of Elevation on Total Emergence

As far as can be determined elevations between 8,000 and 10,000 feet have no influence upon the number of emerging beetles although the two year cycle of some brood occurs at higher elevations. Heaviest emergence this year was not found at the same elevation as last year. The emergence from limber pine in 1936 when figured on a square foot basis was 82.4 at 8,000 feet, 91.5 at 9,000 feet, and 94.4 at 10,000 feet. The greatest number of beetles emerging from a single cage was 400 at 10,000 feet, with an average of 200 per square foot. The lightest emergence and the least number of beetles per square foot was at 8,000 feet where 989 beetles emerged from 12 square feet of bark. Only 67 beetles emerged from one cage at this elevation.

Emergence from lodgepole pine was the reverse of that from limber pine. Heaviest emergence occurred at 8,000 feet with an average of 57.6 beetles per square foot. At 8,500 feet, 56.3 beetles per square foot emerged, at 9,000 feet 31 emerged and at 10,000 feet 45.8 beetles.

One cage at 8,500 feet produced 246 beetles or 123 per square foot while another produced only 8 beetles or 4 per square foot. These figures represent the two extremes from lodgepole pine.

By averaging the number of beetles collected from both hosts we get 71 per square foot at 8,000 feet, 67 at 9,000 feet, and 74 at 10,000 feet. Thus no significant difference in emergence can be attributed to elevation alone.

Effect of Side of Tree on Emergence

Data collected during 1935 indicated that emergence was heaviest from the south side of limber pine but that the reverse was true in lodgepole pine. In 1936 the same general trend was found although exceptions occur at some elevations. From the south side of limber pine beetles averaged 108 per square foot and only 70 per square foot from the north side. From lodgepole pine they averaged 46 per square foot from the south side and 57 per square foot from the north side. Details on this point are graphically illustrated in chart one. No appreciable difference was noted in initial emergence, peak, or end, that might be attributed to side of tree.

Trend of the Epidemic

Although a number of mile long-chain wide strips was laid out and cruised on Elk Mountain in 1935 in order to determine the trend of the epidemic these were not recruised in 1936 so very little specific information is available on this point. They will be cruised early next summer before beetle flight to obtain the 1936 information and again after the flight and attack for the 1937 data.

From general observations there can be no doubt but that the infestation has built up rapidly each year since 1934. The following data on a typical 8-acre strip plot, ranging in elevation from 7,800 feet to 10,000 feet and covered with an even mixture of lodgepole pine and limber pine, indicate the peculiarities and general trend of this epidemic.

Host tree	1934 attacks	1935 attacks	1936 attacks
Limber pine	26	85	278
Lodgepole pine	17	40	45
Total	43	125	323

Based on the total number of trees attacked this infestation has increased at the rate of about 200 percent each year, although a decided preference for limber pine is noted. The trend of the epidemic in direction is toward the top of the mountain. Most of the 1934 attacked trees were found between 8,000 and 9,000 feet elevation. Practically all of the 1935 trees were above 9,000 feet elevation. In 1936 about 85 percent of the attacks were above 9,500 feet and the most of these were around 10,000 feet. Since the available host material around 10,000 feet is very limited, it will be interesting to know where the beetles will go following the 1937 emergence.

An Infestation in Lodgepole Pine

According to Ranger R. R. Riggs of Saratoga, Wyoming a light infestation of the Black Hills beetle was first noticed in 1934 in a mature lodgepole pine stand on the Mullison Creek area of the Medicine Bow National Forest. During the late fall of 1935 this infestation was visited by Messrs. Riggs and Whiteside and it was decided that no control work would be done but the trend of the infestation watched.

The nearest infestation to this area occurred on the Pennock Mountain area about 9 or 10 miles distant from Mullison Creek.

It contained infested limber pine, lodgepole pine, and an occasional ponderosa pine. Since there is no limber pine present and only an occasional ponderosa pine the Mullison Creek infestation appears to have built up in a pure lodgepole pine stand, although there is the possibility of beetles flying into the area from such areas as Elk Mountain and Pennock Mountain.

No control work was done in 1935 on the Mullison Creek area but some cages were installed and some brood counts were made. Emergence in the cages equaled 56.3 beetles per square foot and was almost identical to emergence in cages at 8,000 feet on Elk Mountain. Brood counts made in 1936 throughout the infested length of lodgepole pine trees indicated that twice as many beetles emerged from these trees as attacked them, thus indicating an increase from lodgepole pine of 100 percent.

In the fall and winter of 1936 the Mullison Creek area was treated and 1,612 infested trees cut and burned on an area of approximately 4 sections in size. Groups of abandoned "bug" trees were found in the present infestation and these were all lodgepole pine.

The ranger who has been closely in touch with this lodgepole infestation since it was first observed in 1934 is of the opinion that it has increased each year at the rate of 2 or 3 new trees for each old tree of the previous year's attack.

The evidence in this case, while largely observational, indicates that it is possible for Black Hills beetle infestations to build up to serious proportions in pure stands of lodgepole pine. An annual increase of 100 percent or more is not out of line with the brood count

data obtained to date.

Associated Insects

While a long list of associated insects has been collected both from infested limber pine and lodgepole pine most of these species appear infrequently. Only a few of the more common ones have been specifically determined but in other cases where sufficient material is available they are being submitted for determination. A complete list of all insects collected from the cages during 1935 and 1936 appears in Tables XI and XII with the determinations which have been received to date.

One serious difficulty in connection with the collection of associated insects has been the fact that many of the smaller and more fragile species have gotten in very bad condition in the water in the cans during the period between collections. In cans kept dry the predators often consumed many other insects. It was therefore necessary to keep water in all the cans even though the insects had to be discarded when counted. Following is a list of total collections during 1935 and 1936:

	P. ponderosae	All other species
Limber pine	7,729	779
Lodgepole pine	2,674	671

Summary

A study of the biology and habits of the Black Hills beetle was started in 1935 and continued in 1936.

The main area selected was on Elk Mountain, Wyoming, about five miles outside the Medicine Bow National Forest boundary. The area contained chiefly lodgepole pine and limber pine with occasional other species present. Additional studies were made in a lodgepole pine infestation on Mullison Creek on the Medicine Bow National Forest.

During the past two years a total of 62 cages covering 124 square feet of bark surface, were placed on 42 trees--23 lodgepole pine and 19 limber pine. Nineteen cages were placed at 8,000 feet elevation, 9 at 8,500 feet, 21 at 9,000 feet, and 13 at 10,000 feet.

The emergence from limber pine in 1935 was 9 times as great as from lodgepole pine. In 1936 it was a little less than 2 times as great, although comparative brood counts showed 3 times as much brood in limber pine as in lodgepole pine.

A total of 2,852 beetles emerged from 32 square feet of limber pine in 1936, giving an average of 89.1 beetles per square foot. The most beetles emerging from one square foot was 200 at 10,000 feet. The least number per square foot was 33 at 9,000 feet.

A total of 2,079 beetles emerged from 40 square feet of lodgepole pine bark, giving an average of 51.9 beetles per square foot. The most beetles emerging from one square foot was 123 at 8,500 feet and the least number was 4 at the same elevation.

In 1935 first emergence from limber pine at 8,000 feet was about August 1; the last on September 22; and the duration 47 days. In 1936 it began on July 15; ended September 11; and continued for 58 days. Emergence from lodgepole pine practically coincided with that from limber pine.

At 9,000 feet in 1935 first emergence from limber pine was on August 7; the last October 6; and the duration 60 days. In 1936 it began July 15, and ended September 11, with a duration of 58 days. Lodgepole emergence started a week later but ended at the same time.

At 10,000 feet in 1935 first emergence from limber pine was on August 15; the last October 12; and the duration 56 days. In 1936 some emergence occurred July 10 and a few more beetles came out on the sixteenth. These are believed to be parent adults, the main emergence starting about July 25, ending September 11. Emergence from lodgepole pine also coincided with that from limber pine.

The 1936 emergence started from two weeks to a month earlier than in 1935.

Peak emergence in 1936 averaged about two weeks earlier than in 1935.

Parent adult emergence in 1935 from limber pine totaled 50 from 16 square feet of bark and averaged 3.1 per square foot. In 1936 it totaled 40 from 8 square feet of bark, averaging 5 per square foot.

Parent adult emergence in 1935 from lodgepole pine totaled 39 from 14 square feet of bark and averaged 2.7 per square foot. In 1936 it totaled 72 from 12 square feet of bark and averaged 6 per square foot.

At elevations of 9,000 and 10,000 feet about 9 percent of the beetles in both host species required two years for complete development. These "second year" beetles from 1934-attacked trees emerged late in June and early July 1936 from three to four weeks ahead of normal emergence.

Total beetle emergence appears to be equally heavy from similar host species at all elevations studied.

Emergence was heaviest during both years from the south side of limber pine. The reverse appears to be true in lodgepole pine although the difference is not so great as in limber pine.

Parasites, predators, and associated insects do not appear to be abundant enough to play a very important part in the trend of this epidemic of the Black Hills beetle.

The Elk Mountain infestation has apparently increased since 1934 at the rate of about 300 percent each year.

The Mullison Creek infestation in a pure stand of lodgepole apparently built up from a light infestation in 1934 to over 400 trees per section in 1936.

Recommendations

All strip plots on the area should be cruised before the 1937 emergence and again following it, to further check on the trend of the epidemic.

The cans which were tied up last fall to keep moisture out of them should be lowered to their original positions and partially filled with water or possibly a preservative about the middle of June.

As soon as collections are discontinued on the trees the cages and bark under them should be removed and the exit holes counted and compared with the number of emerging beetles and number of attacks.

All re-emerging parent adults should be saved and classified as to sex. They could also be caged on green logs to find out if they would attack them.

Because of the physical handicaps of carrying on work of this nature on Elk Mountain a more suitable work unit should be found as soon as possible. However because of the progress already made here this study should probably be continued next season.

An assistant should be assigned to the caging study next summer who could devote his full time to the work. In the past this study has been carried on almost entirely by an ECW foreman who was assigned numerous other duties in addition to his entomological studies. As a result of this some important phases of the study have not received the attention they should have and for lack of time and proper assistance others have hardly been touched upon.

In order to secure comparative emergence data additional areas should be selected in other parts of the region and representative trees caged. If infested trees are available and we have the personnel and facilities for carrying on the work it is recommended

that similar studies be started in the ponderosa pine type on the Roosevelt and Arapaho National Forests in Colorado and the Dixie and Powell National Forests in Utah.

TABLE I.--Brood Counts on the Black Hills Beetle

Host Tree	Lodgepole Pine										Limber Pine									
Height on Tree		4 ft.		11 ft.		18 ft.		25 ft.		32 ft		4 ft.		11 ft.		18 ft.		25 ft.		32 ft
Side of Tree		N	S	N	S	N	S	N	S	N S		N	S	N	S	N	S	N	S	N S
	Tree No.										Tree No.									
	1	53	78	14	46	13	8				13	55	29	70	25	91	39	163	81	
	2	34	7	6	1	15					14	157	164	105	158	187	217			
	3	33	3	21	5	31					15	37	122	85	98	26	36			
	4	99	19	73	52	57	25	14	1		16	141	20	112	55	22	84			
	5	70	81	22	36	4	14				17	12	35	17	73	11	20			
	6	93	90	19	32	19	28	5	0		18	212	33	194	-	178	97			
	7	115	67	13	46	61	20	33	39	0	19	225	107	69	44	68	136	70	59	
	8	0	0	29	31	0	0	-		-	20	-	272	127	292	102	127			
	9	-	31	-	-	-	-	-	-	29 22	21	234	310	116	209	-	-			
	10	64	34	37	26	51	23	31	13		22	96	244	103	255	62	95			
	11	32	-	15	-	5	16	59	25		23	174	170	175	190	201	246	211	164	
	12	70	62	109	59	24	61	-	32		24	317	292	271	275	179	102			
Total Brood		663	432	358	334	280	195	142	110	29 22		1660	1796	1444	1674	1127	1199	444	304	
Av. Brood by Sides		60.3	39.3	32.5	33.4	25.5	21.7	28.4	18.3	29 11		150.9	149.6	120.3	152.1	102.5	109.0	148.0	108.3	
Av. Brood by Heights		49.8		32.9		23.7		22.9		17		150.3		135.6		105.7		124.6		
Square ft. Bark Sampled						77										74				
Average all Brood						33.3 per square foot								130.4 per square foot						

TABLE II.-Black Hills Beetle Attacks, Gallery Length, and Brood

Lodgepole Pine		4 ft.			11 ft.			18 ft.			25 ft.			32 ft.		
		Attack per sq.ft.	Gallery inches	Brood per sq.ft	Attack per sq.ft.	Gallery inches	Brood per sq.ft	Attack per sq.ft.	Gallery inches	Brood per sq.ft	Attack per sq.ft.	Gallery inches	Brood per sq.ft	Attack per sq.ft.	Gallery inches	Brood per sq.ft.
	N	10	172	78	7	147	46	6	137	8						
	S	1	73	53	2	47	14	2	24	13						
	S	16	166	3	5	126	5									
	N	18	167	33	9	148	21	8	102	31						
	S	1	21	19	6	90	52	6	102	25	1	29	1			
	N	10	123	99	10	124	73	9	139	57	2	51	14			
	S	11	121	7	2	10	1									
	N	20	167	34	13	146	6	1	37	15						
	S	13	144	61	12	135	36	10	129	14						
	N	16	140	70	7	87	22	9	89	4						
	S	10	100	90	6	67	32	6	64	28	1	14	0			
	N	13	139	93	10	110	19	8	100	19	3	28	5			
	S	7	86	67	4	57	46	1	33	20	5	56	39	3	69	0
	N	9	102	115	9	83	13	4	36	61	4	39	33			
Total		157	1721	802	102	1377	386	70	992	295	16	217	92	3	69	0
Average		11.2	122.9	57.3	7.3	98.4	27.6	5.8	82.7	24.6	2.7	36.2	15.3	1.5	34.5	0
Limber Pine	S	10	118	29	12	95	25	8	110	39	13	131	81			
	N	13	94	55	15	172	70	18	181	91	10	200	163			
	S	17	201	164	19	218	156	10	133	217						
	N	10	148	157	20	154	105	11	160	187						
	S	16	177	122	18	190	98	11	128	36						
	N	19	144	37	19	194	85	14	133	26						
Total		85	882	564	103	1023	541	72	845	596	23	331	244			
Average		14.2	147	94	17.2	170.5	90.2	12	140.8	99.3	11.5	165.5	122			

TABLE III.- Total Emergence of the Black Hills Beetle from Caged Limber Pine - 1936 - New Adults

	8,000 feet		9,000 feet		10,000 feet	
	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage
	#25 - 150 #26 - 118 #29 - 246	#25 - 140 #26 - 67 #29 - 268	#22 - 146 #23 - 117	#22 - 185 #23 - 284	#16 - 83 #17 - 129 #20 - 136	#17 - 400 #31 - 272 #20 - 111
Total Emergence	514	475	263	469	348	783
Square Feet of Bark Caged	6	6	4	4	6	6
Emergence Per Square Foot	85.7	79.2	65.8	117.2	58	130.5
Total Emergence	989		732		1131	
Square Feet of Bark Caged	12		8		12	
Emergence Per Square Foot	82.4		91.5		94.4	
Total Emergence						2852
Square Feet of Bark Caged						32
Emergence Per Square Foot						89.1

Total Emergence of the Black Hills Beetle from Caged Lodgepole Pine - 1936 - New Adults

	8,000 feet		8,500 feet		9,000 feet		10,000 feet	
	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage
	#24 - 167 #27 - 225 #28 - 41	#27 - 99 #28 - 44	# 1 - 246 # 1*- 108 # 3 - 51 # 4 - 96 # 7 - 189	# 2 - 92 # 2*- 64 # 5 - 157 # 6 - 8	#21-cage torn #30 - 47	#21-cage torn #30 - 77	#18 - 32 #19 - 50	#18 - 176 #19 - 108
Total Emergence	433	143	692	321	47	77	82	284
Sq.Ft.Bark Caged	6	4	10	8	2	2	4	4
Emerg.Per Sq.Ft.	72.2	35.8	69.2	40.1	23.5	38.5	20.5	71
Total Emerg.	576		1013		124		366	
Sq.Ft.Bark Caged	10		18		4		8	
Emerg.Per Sq.Ft.	57.6		56.3		31		45.8	
Total Emerg.								2079
Sq.Ft.Bark Caged								40
Emerg.Per Sq.Ft.								51.9

* Plot 2.

TABLE IV.- The Emergence of the Black Hills Beetle from Limber Pine - South Cages, 1936

Date	8,000 feet							9,000 feet						10,000 feet						
	Tree #25	Tree #26	Tree #29	Total	% of Total	Total	% of Total	Tree #22	Tree #23	Total	% of Total	Total	% of Total	Tree #17	Tree #20	Tree #31	Total	% of Total	Total	% of Total
7/10/36														13	0	0	13	1.7	13	1.7
7/15/36	10	0	0	10	2.1	10	2.1	4	11	15	3.2	15	3.2	0	0	0	0	0	13	1.7
7/16/36	2	3	0	5	1.0	15	3.2	5	13	18	3.9	33	7.0	3	0	0	3	.4	16	2.0
7/25/36	49	46	94	189	39.8	204	42.9	16	46	62	13.2	95	20.3	33	10	2	45	5.7	61	7.8
7/31/36	47	11	144	202	42.6	406	85.5	31	43	74	15.8	169	36.0	2	3	1	6	.8	67	8.5
8/ 7/36	0	6	20	26	5.5	432	90.9	82	114	196	41.8	365	77.8	41	2	16	59	7.5	126	16.0
8/14/36	28	1	8	37	7.8	469	98.7	45	55	100	21.3	465	99.1	287	17	166	470	60.0	596	76.1
8/21/36	2	0	0	2	.4	471	99.2	2	0	2	.4	467	99.6	21	63	75	159	20.3	755	96.4
8/28/36	2	0	1	3	.6	474	99.8	0	0	0	0	467	99.6	0	14	10	24	3.1	779	99.5
9/ 4/36	0	0	0	0	0	474	99.8	0	2	2	.4	469	100.	0	2	2	4	.5	783	100.
9/11/36	0	0	1	1	.2	475	100.	0	0	0		469		0	0	0	0	0		

The Emergence of the Black Hills Beetle from Limber Pine - North Cages, 1936

Date	8,000 feet							9,000 feet						10,000 feet						
	Tree #25	Tree #26	Tree #29	Total	% of Total	Total	% of Total	Tree #22	Tree #23	Total	% of Total	Total	% of Total	Tree #17	Tree #20	Tree #16	Total	% of Total	Total	% of Total
7/10/36																				
7/15/36	0	3	0	3	.6	3	.05	5	0	5	1.9	5	1.9							
7/16/36	12	8		20	3.9	23	4.5	2	2	4	1.5	9	3.4	0	0	3	3	.9	3	.9
7/25/36	91	21	80	192	37.4	215	41.8	20	33	53	20.2	62	23.6	18	5	31	54	15.5	57	16.4
7/31/36	43	73	119	235	45.7	450	87.5	16	15	31	11.8	93	35.4	5	2	9	16	4.6	73	20.9
8/ 7/36	0	10	33	43	8.4	493	95.9	45	14	59	22.5	152	57.8	4	7	10	21	6.0	94	27.0
8/14/36	3	2	11	16	3.1	509	99.0	51	32	83	31.6	235	89.4	48	37	23	108	31.0	202	58.0
8/21/36	1	1	2	4	.7	513	99.8	3	18	21	8.0	256	97.3	36	55	5	96	27.6	298	85.6
8/28/36	0	0	1	1	.2	514	100.	2	0	2	.7	258	98.1	12	24	2	38	10.9	336	96.5
9/ 4/36	0	0	0	0	0			0	2	2	.7	260	98.9	4	6	0	10	2.9	346	99.4
9/11/36	0	0	0	0	0			2	1	3	1.1	263	100.0	2	0	0	2	.6	348	100.

TABLE IV.- The Emergence of the Black Hills Beetle from Limber Pine - South Cages, 1936

Date	8,000 feet							9,000 feet						10,000 feet						
	Tree #25	Tree #26	Tree #29	Total	% of Total	Total	% of Total	Tree #22	Tree #23	Total	% of Total	Total	% of Total	Tree #17	Tree #20	Tree #31	Total	% of Total	Total	% of Total
7/10/36														13	0	0	13	1.7	13	1.7
7/15/36	10	0	0	10	2.1	10	2.1	4	11	15	3.2	15	3.2	0	0	0	0	0	13	1.7
7/16/36	2	3	0	5	1.0	15	3.2	5	13	18	3.9	33	7.0	3	0	0	3	.4	16	2.0
7/25/36	49	46	94	189	39.8	204	42.9	16	46	62	13.2	95	20.3	33	10	2	45	5.7	61	7.8
7/31/36	47	11	144	202	42.6	406	85.5	31	43	74	15.8	169	36.0	2	3	1	6	.8	67	8.5
8/ 7/36	0	6	20	26	5.5	432	90.9	82	114	196	41.8	365	77.8	41	2	16	59	7.5	126	16.0
8/14/36	28	1	8	37	7.8	469	98.7	45	55	100	21.3	465	99.1	267	17	166	470	60.0	596	76.1
8/21/36	2	0	0	2	.4	471	99.2	2	0	2	.4	467	99.6	21	63	75	159	20.3	755	96.4
8/28/36	2	0	1	3	.6	474	99.8	0	0	0	0	467	99.6	0	14	10	24	3.1	779	99.5
9/ 4/36	0	0	0	0	0	474	99.8	0	2	2	.4	469	100.	0	2	2	4	.5	783	100.
9/11/36	0	0	1	1	.2	475	100.	0	0	0		469		0	0	0	0	0		

The Emergence of the Black Hills Beetle from Limber Pine - North Cages, 1936

Date	8,000 feet							9,000 feet						10,000 feet						
	Tree #25	Tree #26	Tree #29	Total	% of Total	Total	% of Total	Tree #22	Tree #23	Total	% of Total	Total	% of Total	Tree #17	Tree #20	Tree #16	Total	% of Total	Total	% of Total
7/10/36																				
7/15/36	0	3	0	3	.6	3	.05	5	0	5	1.9	5	1.9							
7/16/36	12	8		20	3.9	23	4.5	2	2	4	1.5	9	3.4	0	0	3	3	.9	3	.9
7/25/36	91	21	80	192	37.4	215	41.8	20	33	53	20.2	62	23.6	18	5	31	54	15.5	57	16.4
7/31/36	43	73	119	235	45.7	450	87.5	16	15	31	11.8	93	35.4	5	2	9	16	4.6	73	20.9
8/ 7/36	0	10	33	43	8.4	493	95.9	45	14	59	22.5	152	57.8	4	7	10	21	6.0	94	27.0
8/14/36	3	2	11	16	3.1	509	99.0	51	32	83	31.6	235	89.4	48	37	23	108	31.0	202	58.0
8/21/36	1	1	2	4	.7	513	99.8	3	18	21	8.0	256	97.3	36	55	5	96	27.6	298	85.6
8/28/36	0	0	1	1	.2	514	100.	2	0	2	.7	258	98.1	12	24	2	38	10.9	336	96.5
9/ 4/36	0	0	0	0	0			0	2	2	.7	260	98.9	4	6	0	10	2.9	346	99.4
9/11/36	0	0	0	0	0			2	1	3	1.1	263	100.0	2	0	0	2	.6	348	100.

TABLE V.-The Emergence of the Black Hills Beetle from Lodgepole Pine - South Cages, 1936

Date	8,000 feet							8,500 feet								9,000 feet					10,000 feet					
	Tree #24	Tree #27	Tree #28	Total	% of Total	Total	% of Total	Tree #2*	Tree #2**	Tree #5	Tree #6	Total	% of Total	Total	% of Total	Tree #30	Total	% of Total	Total	% of Total	Tree #16	Tree #19	Total	% of Total	Total	% of Total
7/10/36																						12	12	4.2	12	4.2
7/16/36	0	5		5	3.5	5	3.5																			
7/18/36									5			5	1.6	5	1.6											
7/25/36	14	14		28	19.6	33	23.0									6	6	7.8	6	7.8	15	32	47	16.5	59	20.7
7/31/36	16	66		82	57.3	115	80.4									0	0		6		15	12	27	9.5	86	30.2
8/1/36								56	54	95	3	208	64.8	213	66.3											
8/7/36	7	9		16	11.2	131	91.6									3	3	3.9	9	11.7	6	9	15	5.3	101	35.6
8/14/36	5	4		9	6.3	140	97.9	31	3	48	4	86	26.8	299	93.1	36	36	46.7	45	58.4	60	18	78	27.5	179	63.0
8/21/36	0	0		0												23	23	29.9	68	88.3	45	25	70	24.6	249	87.7
8/28/36	1	0		1	.7	141	98.6	5	2	9	0	16	4.9	315	98.1	4	4	5.2	72	93.5	19	10	29	10.2	278	97.9
9/4/36	1	1		2	1.4	143	100.									3	3	3.9	75	97.4	2	1	3	1.1	281	98.9
9/11/36									0	4	1	5	1.6	320	99.6	2	2	2.6	77	100.	2	1	3	1.1	284	100.
10/6/36										1		1	.3	321	100.											

- North Cages, 1936

Date	8,000 feet							8,500 feet									9,000 feet					10,000 feet					
	Tree #24	Tree #27	Tree #28	Total	% of Total	Total	% of Total	Tree #1*	Tree #1**	Tree #3	Tree #4	Tree #7	Total	% of Total	Total	% of Total	Tree #30	Total	% of Total	Total	% of Total	Tree #18	Tree #19	Total	% of Total	Total	% of Total
7/10/36																						1	1	1.2	1	1.2
7/16/36		5	4	9	2.1	9	2.1																			
7/18/36									7				7	1.0	7	1.0											
7/25/36	31	91	22	144	33.2	153	35.3										4	4	8.5	4	8.5	12	11	23	28.0	24	29.9
7/31/36	62	69	7	138	31.9	291	67.2										8	8	17.0	12	25.5	2	12	14	17.1	38	46.3
8/ 1/36								231	66	42	67	180	606	87.6	613	88.5											
8/ 7/36	43	43	6	92	21.2	383	88.4										5	5	10.6	17	36.2	6	13	19	23.2	57	69.5
8/14/36	23	16	0	39	9.0	422	97.4	15	32	7	9	6	69	10.0	682	98.5	16	16	34.1	33	70.2	7	9	16	19.5	73	89.0
8/21/36	5	1	0	6	1.4	428	98.8										13	13	27.7	46	97.9	4	4	8	9.8	81	98.8
8/28/36	0	0	2	2	.5	430	99.3	0	3	0	2	3	8	1.1	690	99.7	1	1	2.1	47	100.	0	0	0			
9/4/36	3	0	0	3	.7	433	100.										0	0				1	0	1	1.2	82	100.
9/11/36			0	0				0	0	2	0	0	2	.3	692	100.						0	0	0			
10/6/36																											

* Plot 1. ** Plot 2.

TABLE VI.-Combined Total of Black Hills Beetle Emergence from North and South Cages

Limber Pine - 1936

Date	8,000 ft. 3 Trees	Percent Emerged	Total # Emerged	% of Total	8,500 ft. Trees	Percent Emerged	Total # Emerged	% of Total	9,000 ft. 2 Trees	Percent Emerged	Total # Emerged	% of Total	10,000 ft. 3 Trees	Percent Emerged	Total # Emerged	% of Total
7/10/36													13	1.2	13	1.2
7/15/36	13	1.3	13	1.3					20	2.7	20	2.7	0	0	13	1.2
7/16/36	25	2.5	38	3.8					22	3.0	42	5.7	6	.5	19	1.6
7/25/36	381	36.5	419	42.4					115	15.7	157	21.4	99	8.8	118	10.4
7/31/36	437	44.2	856	86.5					105	14.4	262	35.7	22	1.9	140	12.3
8/ 7/36	69	7.0	925	93.5					255	34.9	517	70.6	80	7.1	220	19.4
8/14/36	53	5.4	978	98.8					183	25.0	700	95.6	578	51.1	798	70.5
8/21/36	6	.6	984	99.5					23	3.1	723	98.7	255	22.5	1053	93.1
8/28/36	4	.4	988	99.9					2	.3	725	99.0	62	5.5	1115	98.5
9/ 4/36	0	0	988	99.9					4	.5	729	99.5	14	1.2	1129	99.8
9/11/36	1	.1	989	100.					3	.4	732	100.	2	.2	1131	100.
10/6/36									0				0			

Lodgepole Pine - 1936

Date	8,000 ft. 3 Trees	Percent Emerged	Total # Emerged	% of Total	8,500 ft. 9 Trees	Percent Emerged	Total # Emerged	% of Total	9,000 ft. 1 Tree	Percent Emerged	Total # Emerged	% of Total	10,000 ft. 2 Trees	Percent Emerged	Total # Emerged	% of Total
7/10/36	0	0	0		0	0	0		0	0	0		13	3.5	13	3.5
7/15/36	0	0	0		0	0	0		0	0	0		0	0	13	3.5
7/16/36	14	2.4	14	2.4	0	0	0		0	0	0		0	0	13	3.5
7/18/36	0	0	14	2.4	12	1.2	12	1.2	0	0	0		0	0	13	3.5
7/25/36	172	29.9	186	32.2	0	0	12	1.2	10	8.1	10	8.1	70	19.1	83	22.6
7/31/36	220	38.2	406	70.4	814	80.4	826	81.6	8	6.5	18	14.5	41	11.2	124	33.8
8/1/ 36	0		406	70.4	0		826	81.6	0		18	14.5	0		124	33.8
8/ 7/36	108	18.8	514	89.2	0		826	81.6	8	6.5	26	20.9	34	9.3	158	43.1
8/14/36	48	8.3	562	97.5	155	15.3	981	96.9	52	41.9	78	62.9	94	25.7	252	68.8
8/21/36	6	1.0	568	98.6	0		981	96.9	36	29.0	114	91.9	78	21.3	330	90.1
8/28/36	3	0.5	571	99.1	24	2.4	1005	99.3	5	4.0	119	95.9	29	7.9	359	98.1
9/ 4/36	5	0.9	576	100.	0		1005	99.3	3	2.4	122	98.3	4	1.1	363	99.1
9/11/36	0				7	0.6	1012	100.	2	1.6	124	100.	3	0.8	366	100.
10/6/36	0								0				0			

TABLE VII.--The Dates and the Number of Days After the Start of the Black Hills Beetle Emergence on Which Important Percentages Occurred

Elevation	Tree Species	First Emergence		50% Emergence		75% Emergence		90% Emergence		Last Emergence	
		South	North	South	North	South	North	South	North	South	North
8,000 feet	Limber Pine	7/15/36	7/15/36	7/25/36 10*	7/25/36 10	7/31/36 16	7/31/36 16	8/ 7/36 23	8/ 7/36 23	9/11/36 58	8/28/36 44
	Lodgepole Pine	7/16/36	7/16/36	7/31/36 15	7/31/36 15	7/31/36 15	7/31/36 15	8/ 7/36 22	8/ 7/36 22	9/ 4/36 50	9/ 4/36 50
8,500 feet	Lodgepole Pine	7/18/36	7/18/36	8/ 1/36 13	8/ 1/36 13	8/ 1/36 13	8/ 1/36 13	8/14/36 26	8/ 1/36 13	10/7/36 80	9/11/36 54
9,000 feet	Limber Pine	7/15/36	7/15/36	8/ 7/36 23	8/ 7/36 23	8/ 7/36 23	8/ 7/36 23	8/14/36 30	8/14/36 30	9/ 4/36 51	9/11/36 58
	Lodgepole Pine	7/25/36	7/25/36	8/14/36 20	8/14/36 20	8/14/36 20	8/14/36 20	8/21/36 27	8/21/36 27	9/11/36 48	8/28/36 34
10,000 feet	Limber Pine	7/10/36	7/16/36	8/14/36 35	8/14/36 29	8/14/36 35	8/21/36 36	8/21/36 42	8/28/36 43	9/ 4/36 56	9/11/36 57
	Lodgepole Pine	7/10/36	7/25/36	8/14/36 35	8/ 7/36 13	8/14/36 35	8/ 7/36 13	8/21/36 42	8/14/36 20	9/11/36 63	9/ 4/36 41

* Number of days after the start of emergence.

TABLE VIII.-Black Hills Beetle - Parent Adult Emergence from Caged Limber Pine

Elevation	8,000 feet		9,000 feet		10,000 feet	
Side of Tree	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage
Tree number			#37 - 7	#36 - 18	#32 - 1	#33 - 14
Total emergence			7	18	1	14
Square feet of bark caged			2	2	2	2
Emergence per square foot			3.5	9	.5	7
Total emergence			25		15	
Square feet of bark caged			4		4	
Emergence per square foot			6.2		3.7	
Total emergence						40
Square feet of bark caged						8
Emergence per square foot						5

-Black Hills Beetle - Parent Adult Emergence from Caged Lodgepole Pine

Elevation	8,000 feet		9,000 feet		10,000 feet	
Side of Tree	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage
Tree number	#27 - 6	#27 - 2	#38 - 28	#38 - 22	#34 - 7	#35 - 5
Total emergence	6	2	28	22	7	5
Square feet of bark caged	2	2	2	2	2	2
Emergence per square foot	4	1	14	11	3.5	2.5
Total emergence	10		50		12	
Square feet of bark caged	4		4		4	
Emergence per square foot	2.5		12.5		3	
Total emergence						72
Square feet of bark caged						12
Emergence per square foot						6

TABLE IX.-Black Hills Beetle Emergence of 1935 and 1936 from 1934 Attacked Trees

Elevation	Side of Tree	Tree Species	1935	1936	Total
9,000 feet	N	Limber pine	343	2	345
9,000 "	N	" "	81	16	97
9,000 "	S	" "	119	10	129
10,000 "	N	Lodgepole pine	154	7	161
10,000 "	S	" "	63	3	66
10,000 "	N	" "	23	1	24
10,000 "	N	Limber pine	509	49	558
10,000 "	S	" "	433	18	451
10,000 "	N	" "	364	37	401
10,000 "	S	" "	250	13	263
10,000 "	N	" "	204	118	322
10,000 "	S	" "	371	8	379
Total emergence			2914	282	3196
Square feet of bark			24		
Beetles per sq.foot			121.4	11.8	133.1
Percent emergence			91	9	100

TABLE X.-The Size and Distribution of the Caged Trees 1935-36

Tree Number	Tree Species	D.B.H.	Height	Number of Cages	Elevation	Slope	Exposure
1	Lodgepole pine	14"	60'	2	8,000 feet	W	W
2	" "	12	50	2	" "	"	"
3	" "	10	50	2	" "	"	"
24	" "	12	45	1	" "	"	N
27	" "	18	60	2	" "	"	W
28	" "	-	-	2	" "	"	N
4	Limber pine	16	45	2	" "	"	S
5	" "	12	40	2	" "	"	"
25	" "	14	30	1	" "	"	"
26	" "	16	40	1	" "	"	W
29	" "	14	45	2	" "	"	"
1*	Lodgepole pine	18	50	1	8,500 feet	-	-
2	" "	16	50	1	" "	-	-
1 Pl.2	" "	16	50	1	" "	-	-
2 Pl.2	" "	14	60	1	" "	-	-
3 Pl.2	" "	14	-	1	" "	-	-
4 Pl.2	" "	16	-	1	" "	-	-
5 Pl.2	" "	18	-	1	" "	-	-
6 Pl.2	" "	16	-	1	" "	-	-
7 Pl.2	" "	16	-	1	" "	-	-
9	Limber pine	10	35	2	9,000 feet	N	N
10	" "	12	40	2	" "	"	"
22	" "	20	40	2	" "	S	S
23	" "	14	30	1	" "	"	"
36	" "	13	-	1	" "	W	W
37	" "	11	-	1	" "	"	"
6	Lodgepole pine	10	35	2	" "	"	N
7	" "	14	50	2	" "	"	"
8	" "	12	40	2	" "	"	"
21	" "	20	60	2	" "	"	S
30	" "	19	60	2	" "	"	W
38	" "	18	-	2	" "	"	"
12	Limber pine	12	25	2	10,000 feet	"	"
13	" "	8	25	2	" "	"	"
14	" "	14	30	2	" "	"	"
16	" "	16	30	1	" "	"	"
17	" "	14	22	1	" "	"	S
20	" "	16	30	1	" "	"	N
32	" "	13	-	1	" "	"	W
33	" "	14	-	1	" "	-	-
34	Lodgepole pine	17	-	1	" "	-	-
35	" "	16	-	1	" "	-	-
	Lodgepole pine average	15.3	51.4	34			
	Limber pine average	13.6	33.8	28			

* All trees at 8,500 feet elevation at Mullison Creek.

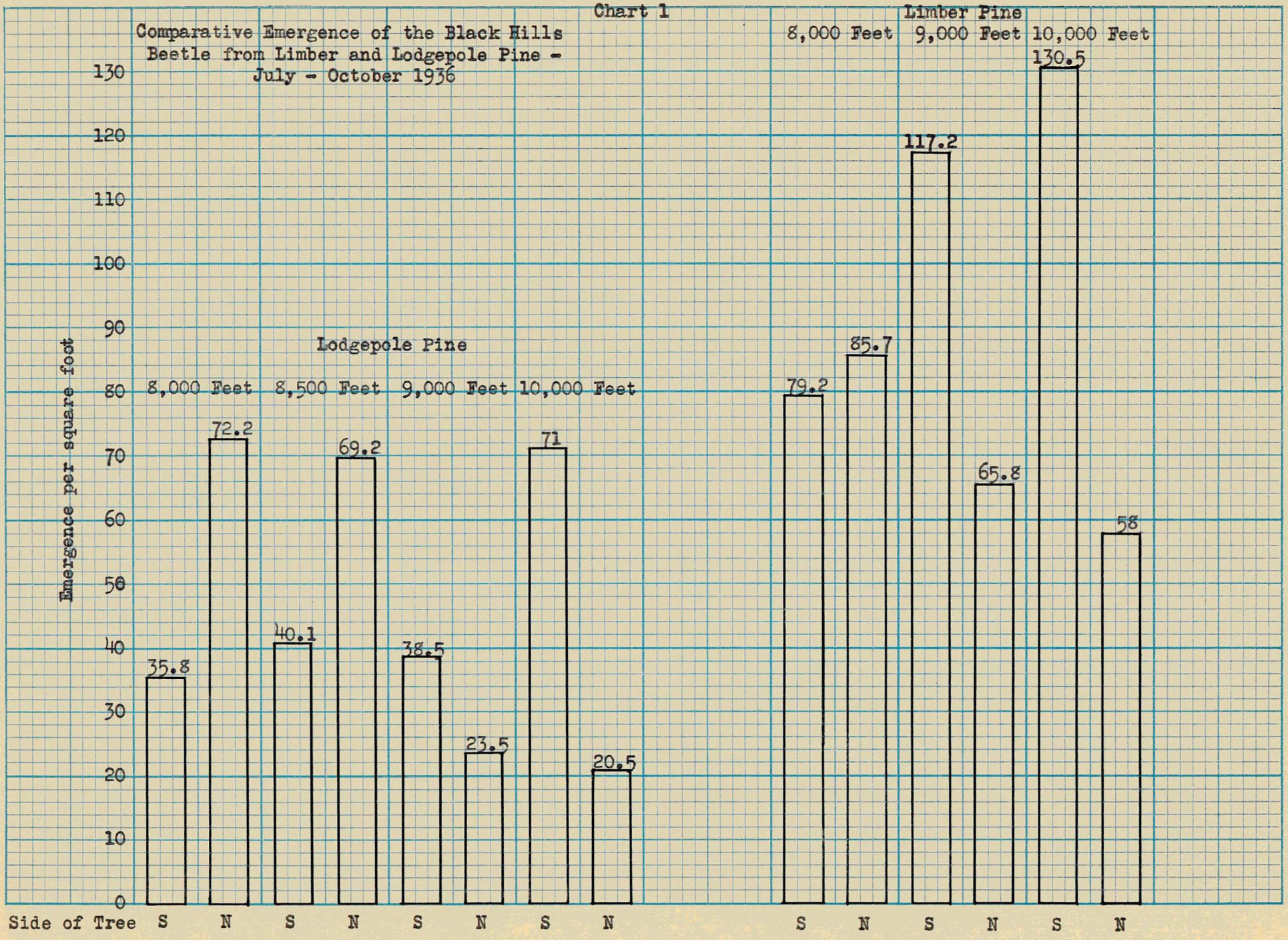
TABLE XI.-List of Insects Collected from Limber Pine 1935 - 1936

Reference Number	Insect	Emergence 1935 First Year Cages	1936 Second Year Cages	1936 First Year Cages	Total
1	Dendroctonus ponderosae Hopk.	4606	271	2852	7729
2	Cleridae	46		19	65
3	Hypophloeus substrictus	42	16	110	170
4	Coleoptera		2	11	13
5	Hemiptera	1			1
6	Aphididae ?	1			1
7	Coeloides dendroctoni	2		2	4
8	Coleoptera	1			1
9	Pityophthorus murrayanae	62		7	69
10	Hemiptera	6	1	3	10
11	Coleoptera and Diptera larvae	58	110	11	179
12	Acanum atrum	1			1
13	Acanthocinus obliquus	2		7	9
14	Arachnida	2		1	3
15	Staphylinidae	1			2
16	Rhizophagus dimidiatus	16	9	3	28
17	Hymenoptera	1			1
18	Coleoptera	1			1
19	Homoptera	1			1
20	Arachnida	56			56
21	Sawfly larvae	2			2
22	Aphididae	1			1
23	Hymenoptera (?)	1			1
24	Dermestidae	1			1
25	Ips integer	9		5	14
26	Dolichopodidae		3	5	8
27	Cleridae			41	41
28	Tenebrionidae			1	1
29	Cleridae			1	1
30	Lepidoptera		1	0	1
31	Stratiomyiidae ?		4	15	19
32	Lepidoptera		5		5
33	Cerambycidae		4	1	5
34	Coleoptera		1		1
35	Arachnida		32	10	42
36	Stratiomyiidae ?		9	4	13
37	Sawfly larva		1		1
38	Ips integer			1	1
39	Cerambycidae		2		2
40	Cleridae			2	2
41	?			1	1
42	Coleoptera			2	2

TABLE XII.-List of Insects Collected from Lodgepole Pine 1935 - 1936

Reference Number	Insect	Emergence 1935 First Year Cages	1936 Second Year Cages	1936 First Year Cages	Total
1	Dendroctonus ponderosae Hopk.	584	11	2079	2674
2	Cleridae - larvae	9	1	13	23
3	Braconidae	7		24	31
4	Hypophlocus substriatus	17	2	18	37
5	Braconidae - adult	3		22	25
6	Braconidae - adult	1		1	2
7	Lepidoptera - adult	1	1	52	54
8	Lepidoptera - adult	3	1	17	21
9	Diptera - larvae	4		39	43
10	Pityophthorus	6		3	9
11	Rhizophagus dimidiatus	2		36	38
12	Lepidoptera - adult	3	1	1	5
13	Diptera - adult	1		1	2
14	Asemum atrum	2	1	2	5
15	Enoclerus sp. - adult	1		1	2
16	Thysanoptera	38		6	44
17	Coleoptera - larva	1		4	5
18	Arachnida	1		0	1
19	Coeloides dendroctoni	40	5	11	56
20	Arachnida (mites)	45			45
21	Arachnida	1	10	1	12
22	Chilopoda	1			1
23	Enoclerus sp. - adult	1		1	2
24	Coleoptera (Cer. lar.)	2	12	1	15
25	Cleridae (larva)		3	4	7
26	Sawfly larvae		3	1	4
27	Hemiptera		1	6	7
28	Cleridae - larva			20	20
29	Sawfly larva			2	2
30	Coleoptera - adult		2		2
31	Enoclerus sp. - adult		1	4	5
32	Coleoptera - 1 adult			1	1
33	Arachnida		21	7	28
34	Acanthocinus obliquus		1		1
35	Coleoptera - adult		1	1	2
36	Lepidoptera		1	2	3
37	Trypodendron sp.			46	46
38	Rhizophagus dimidiatus			1	1
39	Coleoptera - larva			24	24
40	Coleoptera - larva			1	1
41	Diptera - larva			29	29
42	Stratiomyidae - larva			5	5
43	Coleoptera - adult			1	1
44	"			1	1
45	Coleoptera - 3 adults			4	4

Chart 1


Comparative Emergence of the Black Hills Beetle from Limber and Lodgepole Pine - July - October 1936
Emergence per square foot
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Lodgepole Pine
8,000 Feet
8,500 Feet
9,000 Feet
10,000 Feet
35.8
72.2
40.1
69.2
38.5
23.5
71
20.5
Limber Pine
8,000 Feet
9,000 Feet
10,000 Feet
79.2
85.7
117.2
65.8
130.5
58
Side of Tree
S
N
S
N
S
N
S
N
S
N
S
N

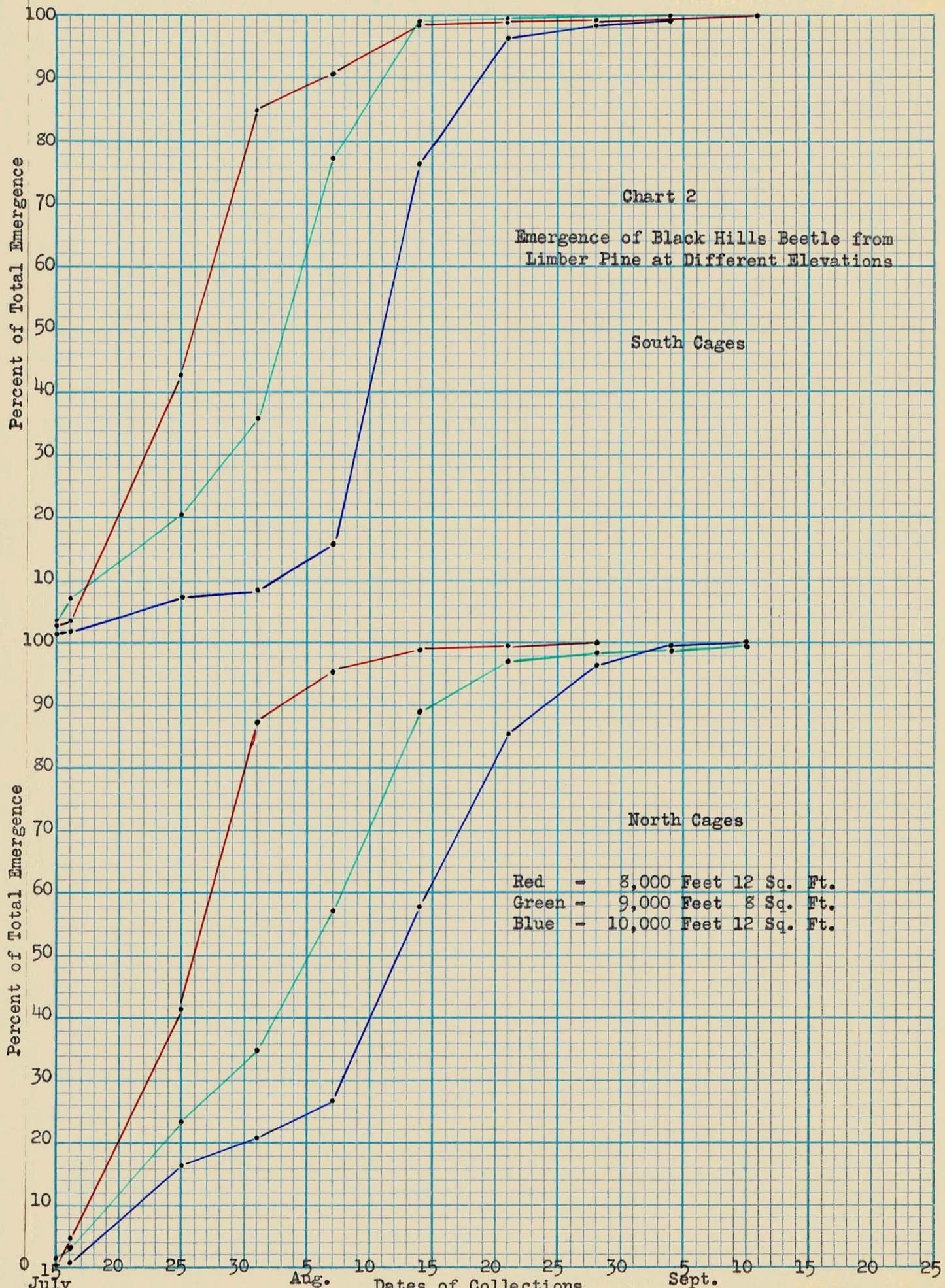


Chart 2
Emergence of Black Hills Beetle from Limber Pine at Different Elevations
South Cages
North Cages
Red - 8,000 Feet 12 Sq. Ft.
Green - 9,000 Feet 8 Sq. Ft.
Blue - 10,000 Feet 12 Sq. Ft.
Percent of Total Emergence
Percent of Total Emergence
Dates of Collections
July
Aug.
Sept.
0
10
20
30
40
50
60
70
80
90
100
15
20
25
30
5
10
15
20
25
30
5
10
15
20
25

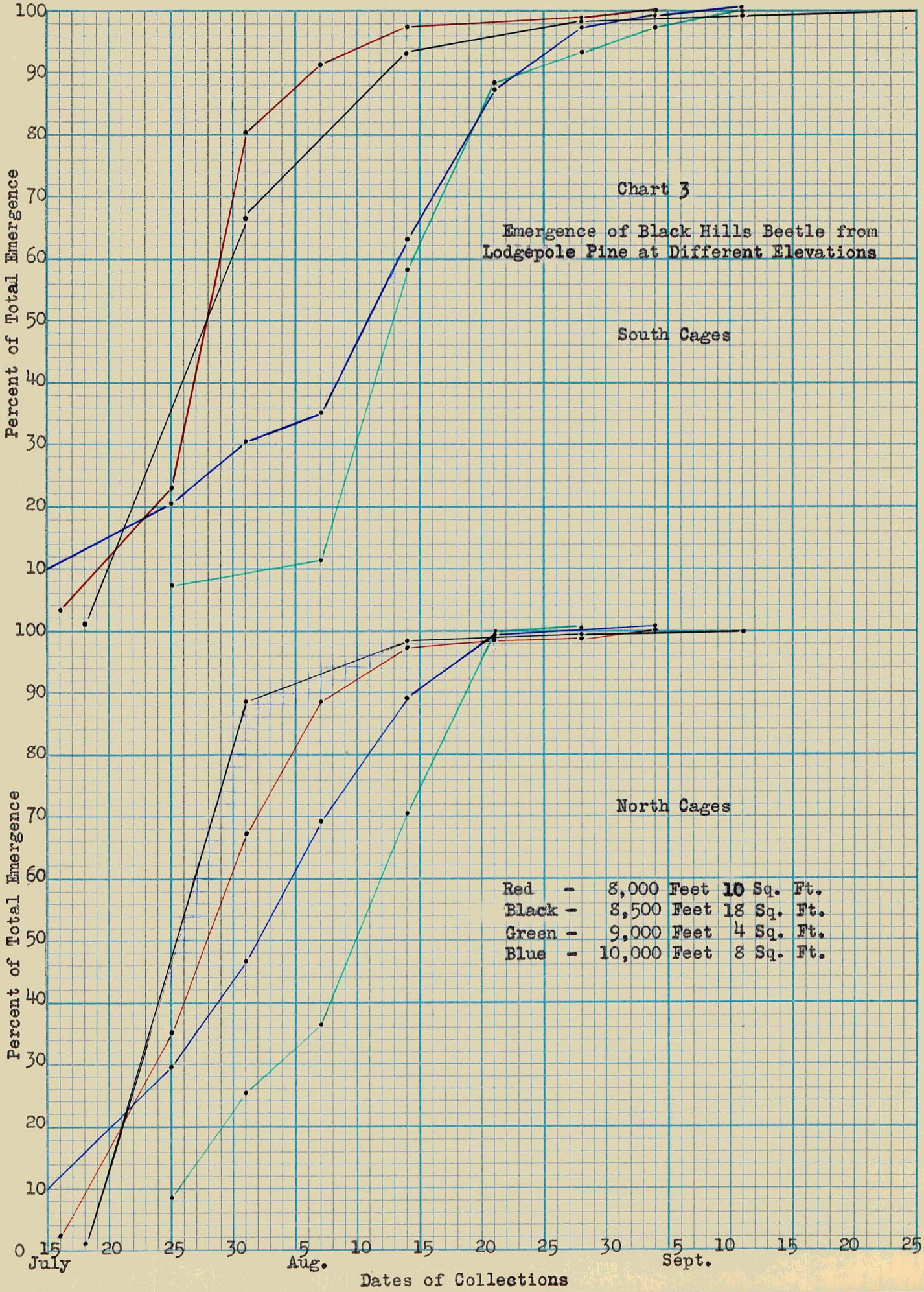


Chart 3
Emergence of Black Hills Beetle from Lodgepole Pine at Different Elevations
South Cages
North Cages
Red - 8,000 Feet 10 Sq. Ft.
Black - 8,500 Feet 18 Sq. Ft.
Green - 9,000 Feet 4 Sq. Ft.
Blue - 10,000 Feet 8 Sq. Ft.
Percent of Total Emergence
Percent of Total Emergence
0 15 20 25 30 5 10 15 20 25 30 5 10 15 20 25
July
Aug.
Sept.
Dates of Collections

Chart 4

Black Hills Beetle - Emergence per Square Foot from Lodgepole Pine at Three Elevations July to October 1936

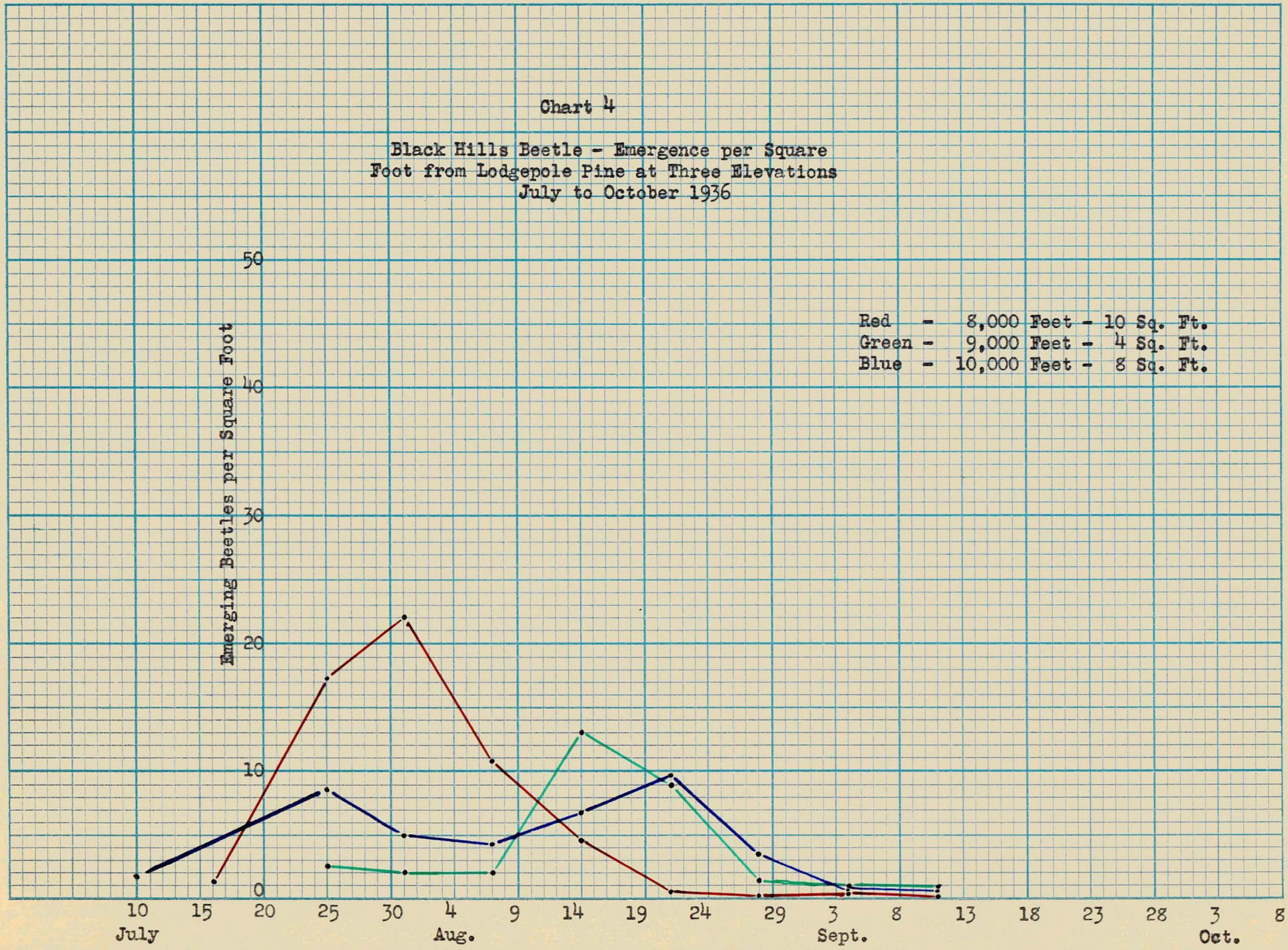


Chart 5

Black Hills Beetle - Emergence per Square Foot from Limber Pine at Three Elevations July to October 1936